**NATIONAL ACADEMIES OF SCIENCES AND ENGINEERING**

**NATIONAL RESEARCH COUNCIL**

**of the**

**UNITED STATES OF AMERICA**

**UNITED STATES NATIONAL COMMITTEE**

**International Union of Radio Science**


# National Radio Science Meeting

4–8 January 2000

Sponsored by USNC/URSI

University of Colorado
Boulder, Colorado
U.S.A.

A/D1-7
16:20

## WIDEBAND FERROELECTRIC COPLANAR WAVEGUIDE PHASE SHIFTERS

Jeffrey M. Pond, Steven W. Kirchoefer, Edward J. Cukauskas, Won-Jeong Kim, and James S. Horwitz
Naval Research Laboratory
Washington, DC 20375

We are developing room temperature thin-film ferroelectric materials for use in distributed microwave components such as phase shifters. Phase shifter applications of ferroelectric thin films are more compatible with the present state of refinement of ferroelectric thin films than other applications, such as ferroelectric varactors (S.W. Kirchoefer, et al., *Micro. and Opt. Tech. Lett., 18*, 168-171, 1998). This offers the possibility of yielding components that are competitive with the best results of conventional approaches, yet does not depend critically upon significant new materials advances. Success has already been documented in the literature for phase shifters using a narrow-band design on ferroelectric thin films, with insertion losses on the order of 5 dB. (van Kuels et al., *Micro. and Opt. Tech. Lett. 20*, 53, 1999). Initial results on broadband phase shifters, although not achieving an optimal match, show very promising results.

Our effort involve several different approaches to obtaining ferroelectric thin films which simultaneously possess low dielectric loss tangent and reasonable modulation of the relative permittivity with an applied dc field. Pulsed-laser-deposition is the most extensively studied deposition system for ferroelectric thin films and considerable progress has been made in correlating the microstructure of the material with its microwave properties. More recently, magnetron sputtering techniques have demonstrated the potential to produce ferroelectric films with properties suitable to microwave device applications. Comparisons between the deposition techniques and the measured properties are providing useful information to help refine both deposition processes.

In addition to a discussion of measured results and design issues for phase shifter applications, the potential to use these elements as building blocks for tapped delay lines to realize transversal filters, will be addressed. Tunable filter and oscillator applications are other possible applications which will become highly desirable as modest improvements are made in the material properties of the ferroelectric thin films.